

The Three Ancient Radiation

Gravitation Waves

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Three Ancient Radiation: Remnant radiation from the cosmic fireball

- Cosmic Microwave Background (CMB)
 - Discovery in 1965
 - Arno Allan Penzias (b. 1933), Robert Woodrow Wilson (b. 1936)
 - Antenna at Bell Telephone Laboratories: for work on communication satellites
 - Nobel prize in 1978 for:
 - Watching the birth of the Universe
 - Observing the most ancient radiation in the universe
 - Providing evidence for the Big Bang model
 - Photons – Electromagnetic waves
 - $T = 2.725 \text{ K}$; $E = 2.3 * 10^{-4} \text{ eV}$, $z @ 1000$
 - $1\text{K} \leftrightarrow 8.6 * 10^{-5} \text{ eV}$

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- Cosmic Microwave Background (CMB)
- Cosmic Gravitational Waves (CGW)
 - Gravitons – Gravitational waves
 - discovery Mar, 2014
 - <http://www.nature.com/news/gravitational-wave-finding-causes-spring-cl>
 - BICEP2 Collaboration @ South Pole: Background Imaging of Cosmic Extragalactic Polarization II @ 100 GHz
 - Nobel prize in 2015? – "First direct evidence of cosmic inflation"
- Cosmic Neutrino Background (CNB)

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- Cosmic Microwave Background (CMB)
- Cosmic Gravitational Waves (CGW)
- Cosmic Neutrino Background (CNB)
 - Neutrinos – in Electroweak Interaction
 - $T = 1.945$; $E = 1.67 * 10^{-4}$ eV
 - Observation:
 - How?
 - when?